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Alternative Measures of Rifle Skills

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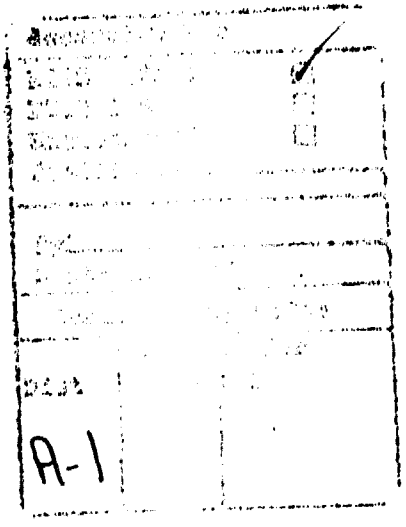

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Alternative Measures of Rifle Skills

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ABSTRACT

This paper addresses issues related to the use of alternative and surrogate tests of the skills associated with rifle firing.

EXECUTIVE SUMMARY

Proficiency in firing a rifle is fundamental to success in a number of Marine Corps infantry specialties; therefore, obtaining useful information about this skill is essential to validating infantry selection criteria and diagnosing possible training needs. This Job Performance Measurement (JPM) study answered the following questions:

1. *How similar are the abilities to hit stationary targets (measured by HMF known-distance (KD) requalification scores) and to hit pop-up targets (measured by JPM pop-up target scores)?*

The correlation of KD scores and pop-up target scores was only .2. This result suggests that alternative measures of rifle-firing ability can be distinct. It indicates the importance of current Marine Corps efforts to develop tests of the ability to fire at pop-up targets, since Marines will practice for whichever requalification test is required, and the pop-up target test more closely simulates actual battle conditions than the KD test.

2. *Is there room for a new test to enhance the usefulness of the Armed Services Vocational Aptitude Battery (ASVAB) in infantry selection?*

This research found that motor skills are distinguishable from cognitive skills, and that no present composite of the ASVAB predicts rifle-firing ability, especially for pop-up targets. These findings indicate that the validity of the ASVAB can be improved by adding tests that correlate with rifle-firing skills.

3. *To what extent are computerized video-firing tests reliable and valid? To what extent do they yield results similar to KD target scores and pop-up target scores?*

Results of video firing games were found to be reliable and moderately correlated with KD (.41); however, they were only weakly correlated with pop-up target scores (.17). The dissimilar results yielded by these video firing games makes them potential surrogates for KD target scores, but not for pop-up target scores.

4. *Are there practice effects associated with use of computerized video-firing tests that might invalidate use of a video test as a surrogate measure of rifle-firing skill?*

Practice effects on video tasks ranging from 0.2 to 0.4 standard deviation were found. Consequently, even if computerized tests of rifle-firing skills prove otherwise valid, practice effects would still be a concern. Practice effects can negate the test's usefulness because they interfere with test equating, making it difficult to compare scores from year to year. In addition, practice effects make scores invalid if some applicants practice before the test and others do not.

5. *Can potential noncomputer surrogates of rifle-firing skills, such as proficiency marks, training GPA, or job-knowledge tests, yield results similar to a HOPT?*

Noncomputer surrogates had correlations ranging from .16 to .31 for KD target scores and from .05 to .12 for pop-up target scores. These figures indicate that noncomputer measures *do not* yield results similar to either performance test of rifle-firing skills.

In conclusion, rifle firing is a more context-specific skill than previously thought. Current Marine Corps efforts to develop tests of ability to hit pop-up targets are important. Only greater attention to the specifics of rifle-firing skill and practice effects will yield alternative measures that should be used in conjunction with ASVAB.

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INTRODUCTION

Proficiency in firing a rifle is fundamental to success in a number of Marine Corps infantry specialties; therefore, obtaining useful information about this skill is essential to validating infantry selection criteria and diagnosing possible training needs. It is important to understand the relationships among alternative measures of the skills associated with rifle firing. Ability to hit stationary targets (measured by HMF known-distance (KD) requalification scores) might be distinct from skill at hitting pop-up targets. Pop-up target practice is probably closer to actual combat conditions. The first questions addressed by this paper are as follows: (1) How similar are the abilities to hit stationary targets (KD scores) and to hit pop-up targets (JPM scores)? And, (2) Is there room for a new measure of motor skills to enhance the usefulness of ASVAB in infantry selection? The JPM tasks are similar to those required of personnel using the new multipurpose (live-fire) range complex (MPRC) at Camp Pendleton.

A surrogate is a substitute indicator of job proficiency that is reliable and valid, and yields results similar to a hands-on performance test (HOPT). Testing of rifle-firing abilities might be enhanced by using computer surrogates, since previous research has shown that paper-and-pencil tests are unable to measure physical performance skills [1, 2]. The computer's ability to time responses, to present high-quality moving graphics, and to accept complex motor responses through devices such as a joy stick make it a potentially useful tool for measuring rifle-firing aptitudes and skills. Computers might assess abilities that have typically been unassessable through traditional paper-and-pencil tests [3]. Motor skills, hand-eye coordination, and reaction time are among the characteristics a computer might test. As a result of these potentials, the armed services are sponsoring research on enhanced computer-assisted testing (ECAT). Among the unresolved issues are the following: (1) whether computerized tests will prove valid if evaluated with adequate criteria; and (2) whether computerized tests are susceptible to strategy, coaching, and/or practice effects [4]. Practice effects can negate the usefulness of a test because they interfere with test equating, making it difficult to compare scores from year to year. In addition, practice effects make scores invalid if some applicants practice before the test and others do not.

Though computer software packages can potentially be made into useful predictors and measures of rifle skills, more readily available indicators might be used. For example, proficiency marks, training grade-point average (GPA), or a job-knowledge test might yield the same results as computerized or hands-on measures of rifle-firing skill.

This paper uses data from the Marine Corps JPM Project to address the following questions:

- How similar are the abilities to hit stationary targets (measured by HMF KD scores) and to hit pop-up targets (measured by JPM pop-up target scores)?
- Is there room for a new test to enhance the usefulness of the Armed Services Vocational Aptitude Battery (ASVAB) in infantry selection?
- To what extent are computerized video firing tests reliable and valid? To what extent do they yield results similar to KD and pop-up target scores?
- Are there practice effects associated with use of computerized video firing tests that might invalidate use of a video test as a surrogate measure of rifle-firing skills?
- Can potential noncomputer surrogates of rifle-firing skills, such as proficiency marks, training GPA, or job-knowledge tests, yield results similar to a HOPT?

METHOD

Subjects

This research used data on first-term enlisted infantry Marines in three military occupational specialties. The following numbers were used as sampling targets:

Riflemen (0311)	1,200
Machine Gunners (0331)	300
Mortarmen (0341)	300

Measures

Criteria

HMF Rifle Requalification KD Scores. At least once annually, enlisted Marines under the age of 34 and the rank of E-8 are tested on their ability to shoot a rifle at stationary targets from 200, 300, and 500 yards. Rifles are fired while assuming a variety of combat positions, such as prone, standing, or sitting [5]. Marines are

given multiple tries from each position for a given distance. The resulting scores and the dates they were earned are kept on the USMC Headquarters Master File. KD scores used in this research, which included only first-term Marines in three MOSs, ranged from a low of 128 to a high of 242, out of a possible 300.

Pop-up Target Scores. JPM pop-up target scores involve a different mix of firing skills than are needed for KD requalification. Whereas KD requires shooting at stationary targets, pop-up target scores involve a scenario in which each Marine is required to walk along a trail, guarding a particular flank, and responding to pop-up targets that appear for a limited number of seconds. Therefore, pop-up target scores involve the ability to respond and aim quickly from a walking position.

The final score for each Marine for the pop-up target test is a composite of two scores: zeroing the weapon (LFO1) and engaging the target (LFO2). Zeroing an M16A2 rifle refers to calibrating it so that the infantryman can engage most targets without having to adjust the sites [5]. The final grade for target engagement was an efficiency score (hits/rounds fired). Appendix A shows the score sheets for both target-engagement and battlesight-zero tasks. The overall pop-up composite was computed LFIRE=0.2*LF01 + 0.8*LF02. Figure 1 shows the distribution of scores.

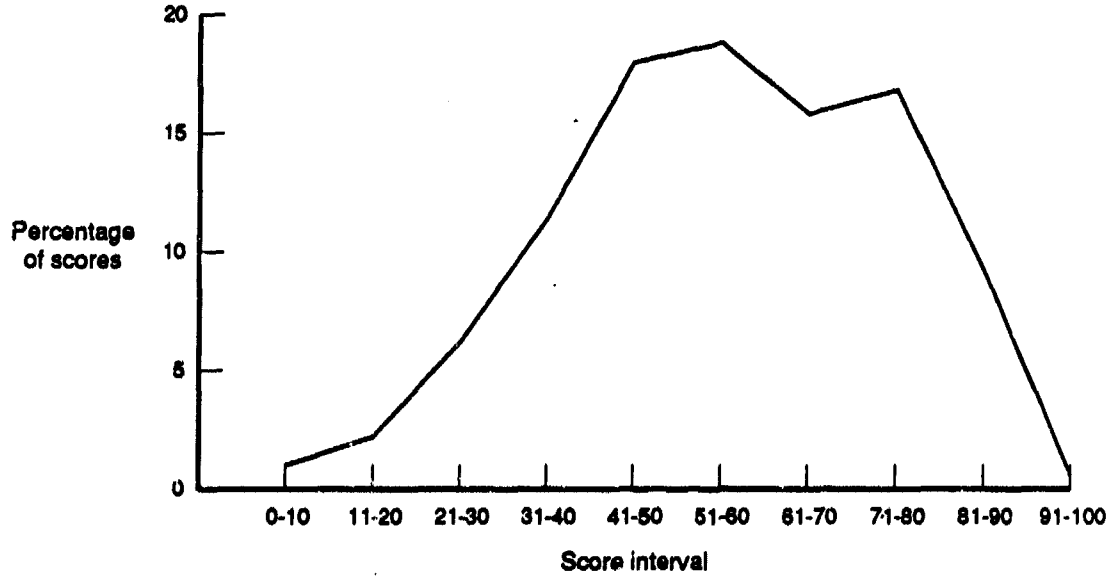

Figure 1. Distribution of JPM pop-up target scores by score interval

Recency scores for firing and zeroing a rifle were obtained by asking each examinee the last time that he performed the task. Categories and codings were as follows [4]: less than one week (5), less than one month (4), less than six months (3), greater than six months (2), and never, have received instruction only (1).

Frequency scores were computed in an analogous fashion to the recency scores. Frequency was coded as the answer to the question, "How many times have you done this task during the last six months?". Responses were coded as more than 10 (times) (4), 3 to 10 (times) (3), 1 or 2 (times) (2), and None (1).

Proxies

Video Firing Games. Scores on video firing games would be useful surrogates for hands-on tests of rifle-firing skills, since video would be less expensive, safer, and use no ammunition. Therefore, four commercial video firing games were administered as experimental surrogates. The video firing sequences were chosen because they involved the ability to aim and shoot at a moving target [6]. The tests were video simulations of trapshooting and a safari hunt.

- *Trap shooting.* Ten targets were presented, two at a time, for each of five levels of complexity. The Marine was given three shots for each set of two targets. Each Marine shot two trials, consisting of a maximum of five levels each. Whether or not the Marine actually completed all five levels depended on his proficiency (on previous levels of the test). Each Marine thus continued to shoot as many levels as he could, but was limited to five levels per trial; two trials were shot in total. The test administrator (TA) stopped the video at the completion of each of the two trials and recorded the Marine's total score for each one.

- *Safari hunt.* Three scenes were presented (as levels) to the Marine in the safari hunt video test. A variety of animals with different point values served as the targets. A total of 30 shots were allowed per level to shoot as many targets as possible. Each Marine completed two trials, consisting of a maximum of five levels, depending on his ability to progress through the levels. The TA stopped the video at the end of each trial to record the total score for each trial [6, p. 69].

In summary, the trapshooting test measured the ability to aim and shoot at moving targets presented two at a time, while the safari hunt measured the ability to shoot at a number of moving targets presented simultaneously.

The trapshooting and safari video tests lasted approximately eight minutes each. Scores for each task ranged from the mid-30s to 100. The overall scores collected for these tasks was the sum of four standardized scores, two trials for each of the tasks (i.e., TRAP1, TRAP2, SAFARI1, SAFARI2). These overall video scores ranged from approximately 150 to 300, as can be seen in table 1.

Table 1. Standardized video firing values by MOS

	Mean	Standard deviation	Minimum	Maximum
Riflemen (MOS 0311), n = 812				
TRAP1	48.85	9.74	39.00	89.00
TRAP2	49.08	9.93	37.00	89.00
SAFARI1	49.16	9.68	37.00	84.00
SAFARI2	49.23	9.75	36.00	78.00
VIDEO-SUM	196.32	31.31	149.00	286.00
Machine gunners (MOS 0331), n = 259				
TRAP1	50.76	10.10	39.00	87.00
TRAP2	50.67	10.35	37.00	98.00
SAFARI1	51.10	10.57	37.00	81.00
SAFARI2	50.08	10.24	37.00	80.00
VIDEO-SUM	202.61	33.03	150.00	296.00
Mortarmen (MOS 0341), n = 232				
TRAP1	51.52	10.08	39.00	89.00
TRAP2	51.68	9.44	37.00	76.00
SAFARI1	50.09	10.33	37.00	83.00
SAFARI2	50.91	10.88	37.00	80.00
VIDEO-SUM	204.19	33.11	150.00	300.00

NOTE: Scores were standardized to have mean 50 and standard deviation 10.

Examinees were also asked to estimate how often they had played video games. The resulting *video frequency* scores were coded as follows in answer to the question, "In the last few years, how much have you played video games on arcade machines, home video games, or home computers?" (1) never, (2) less than once a month, (3) several times a month, (4) once or twice a week, and (5) almost every day. After

the trapshooting and the safari trials, examinees were also asked whether they had ever played that particular game before.

Field Proficiency and Conduct Ratings. Field proficiency and conduct ratings were taken from each Marine's permanent records. Marines are rated biannually. They also are rated when transferred to a new unit or a major event occurs in the Marine's career (e.g., promotion or confinement). Since Marines had varying amounts of military experience, the number of ratings ranged from a low of 1 to a high of 18. The rating score used for these analyses was the mean of all ratings a Marine had received. The mean rating score maintained the 0.0 to 5.0 scale.

School of Infantry Grade-Point Average (GPA). Training grades were collected from the School of Infantry for each MOS that was tested. The school at which the Marine was initially trained does not necessarily correspond to the base at which the Marine was stationed at the time of testing.

Job-Knowledge Tests. The paper-and-pencil job-knowledge tests were developed to parallel the overall hands-on content as much as possible. This included questions concerning the 12 infantry duty areas: communications; first aid; grenade launchers; hand grenades; light antitank weapons; land navigation; land mines; nuclear, biological, and chemical defense (NBC); night vision; squad automatic weapon; security and intelligence; and tactical measures. Therefore, the job-knowledge test was a general measure of hands-on proficiency, with no content specific to firing a rifle. The final general infantry (0300) test consisted of 150 items to be completed in 90 minutes.

Supervisor Rating Form. Each Marine was rated by his platoon sergeant. The platoon sergeants have frequent enough interactions with their Marines to accurately rate the proficiency of each Marine in the performance of his duties. The rating form consisted of two questions: "How much assistance does this Marine require to do his job?" and "If your unit deployed tomorrow, would you want this Marine to deploy with you?" Both questions were answered on a 1-to-7 scale; the first was labelled from "Can't Do the Job" to "No Assistance," while the second ran from "Definitely No" to "Definitely Yes."

RESULTS

Reliability

Criteria

As described earlier, there are two types of rifle-firing scores analyzed in this research. These could be considered alternative criteria:

- *KD scores.* These scores, taken from the HMF requalification scores, summarize the Marine's performance when hitting stationary targets from a variety of combat positions.

- *Pop-up target scores.* These scores are taken from the JPM tests of the Marine's ability to hit pop-up targets.

This section discusses the reliability of these criteria.

For this research, there were no data concerning the test-retest reliability of the KD scores kept in the HMF file. Test-retest reliability is usually computed from scores on tests taken 5-22 days apart, but KD scores from the HMF are based on performances approximately 12 months apart. Therefore, KD scores in successive years are measures of growth or deterioration of skills rather than test-retest reliability. However, there are data on the reliability of the pop-up target scores from the JPM project.

JPM pop-up target scores were taken from 188 riflemen (0311s) once and then again two weeks later. The initial scores ranged from 43 to 156, with a mean score of 99.07 and a standard deviation of 21.49. The second testing showed improvement of scores, with a range of 56 to 147 and a mean score of 107.75 and a standard deviation of 17.84. This translates to an average improvement of 0.40 standard deviation between initial testing and retest. The test-retest reliability was .45.

Surrogates

When *video marksmanship trials* were considered as four items on a scale and data from all infantrymen were combined, alpha consistency reliability was computed to be .82. This figure is high enough to support the claim that similar skills are measured across video tasks. The test-retest reliability was computed to be .63 for the 211 who were retested seven to ten days after initial testing. This

figure is adequate, but somewhat low. The average test-retest gain of 22.6 points, or about three-fourths of the initial standard deviation of 30.3, indicates that most examinees improved their scores [7].

Proficiency marks were evaluated using the ANOVA reliability because the number of marks varied. The results of the analyses are in table 2. As can be seen, the three, four, and five most recent ratings had reliabilities approaching .70. These reliabilities are somewhat lower than those of the supervisor ratings because they represent ratings made at different times by different individuals. However, these reliabilities are somewhat higher than those found in other research on rating scales. Previous research [8] has shown that proficiency marks cluster between the highest ratings of 4.0 and 5.0, thereby lowering reliabilities.

Table 2. Reliability of proficiency ratings

Reliability measure	Reliability estimate	Mean squares		N
		Between	Within	
ANOVA reliability				
3 most recent ratings	.66	24.09	8.17	1,755
4 most recent ratings	.67	25.54	8.42	1,406
5 most recent ratings	.70	25.42	7.67	1,104

Reliabilities for the *field conduct ratings* were computed in the same way as the proficiency ratings. The results (table 3) show that the field conduct ratings were approximately as reliable as the field proficiency scores. These reliabilities are of sufficient magnitude that the correlations of the ratings with other variables can be properly interpreted.

Table 3. Reliability of conduct ratings

Reliability measure	Reliability estimate	Mean squares		N
		Between	Within	
ANOVA reliability				
3 most recent ratings	.70	52.0	15.7	1,583
4 most recent ratings	.70	58.4	17.4	1,272
5 most recent ratings	.71	58.9	17.2	992

Supervisor ratings were taken from the enlisted Marine's NCO. When the ratings were considered as items on a scale, and data from all infantrymen were combined, alpha reliability was computed to be .81. This degree of consistency is quite high because, unlike proficiency ratings (described above), supervisor ratings were made by the same person at the same time.

The correlation between two administrations of the same *job-knowledge test* administered to 189 riflemen with a seven- to ten-day interval was .73. This degree of reliability is adequate, but not particularly high.

Cronbach alpha coefficients computed for the job-knowledge test were .89 for MOS 0311 (199 items, n = 1,296), .89 for MOS 0331 (190 items, n = 306), and .90 for MOS 0341 (189 items, n = 312). The difference between alternate test forms never varied by more than .02 for any MOS, and the overall alpha was .87. These figures suggest that different parts of the job-knowledge test were measuring the same skills.

Validity

Criteria

As described earlier, there are two types of riflery scores analyzed in this research: (a) *KD scores*, summarizing the Marine's performance on annual rifle requalification tests when hitting stationary targets; and (b) *pop-up target scores*, based on his ability to hit pop-up targets while walking along a trail. This section describes the relationships between these two alternative criteria.

Table 4 shows that rifle classifications are derived from rifle scores. Those with scores of 190 to 209 are termed "marksmen," with scores of 210 to 219 are labeled "sharpshooters," and those with scores over 220 are called "experts." Those with scores under 190 are termed unqualified.

The study's first question concerns whether KD and pop-up target scores measure the same ability. Table 5 shows that the relationship of pop-up target scores to KD rifle classification is unclear. The range of pop-up target scores is almost identical for marksmen and sharpshooters. Even personnel scoring as experts on USMC rifle requalification scored as low as 9 on the JPM pop-up target test. Table 5 indicates that the ability to hit pop-up targets is distinct from the ability to hit KD targets.

Table 4. Rifle scores by rifle classification

	Unqualified	Marksmen	Sharpshooters	Experts
Mean rifle score	176.2	201.2	214.9	227.0
Percentage of examinees	1.6	33.3	26.3	38.9
(n)	(20)	(425)	(336)	(497)
Standard deviation	15.6	5.4	2.6	4.8
Range	128-189	190-209	210-219	220-242

Table 5. Pop-up target scores by rifle classification

	Unqualified	Marksmen	Sharpshooters	Experts
Mean pop-up target score	37.2	49.4	51.2	55.0
Percentage of examinees	1.6	33.0	26.3	38.9
(n)	(20)	(425)	(336)	(497)
Standard deviation	15.2	17.3	15.5	15.9
Range	6-65	4-95	5-95	9-95

The study's second question is whether a new test could enhance the ASVAB's usefulness in predicting rifle skills. The pattern of correlations presented in table 6 shows that although general technical (GT), mechanical maintenance (MM), electrical repair (EL), clerical/administrative (CL) and AFQT predict hands-on total scores, these aptitude composites are weak-to-moderate predictors of pop-up target or KD scores. This is partly because paper-and-pencil tests are poor surrogates for hand-eye coordination tasks [1, 2]. ASVAB does considerably better when predicting overall hands-on scores and video Safari hunt scores than when predicting pop-up target or KD scores. Appendix B presents the correlations uncorrected for range restriction.

The study's third question is whether computerized video firing tests are valid measures of rifle skills. The trapshooting video tasks were administered immediately before the safari hunt video tasks, so the examinees took the tests in the following order: TRAP1, TRAP2, SAFARI1, SAFARI2. Table 6 indicates that these particular tests were better surrogates for KD than for pop-up target scores. It is interesting to note that the ASVAB composites correlate higher with the Safari tasks, which were administered later in the session. This finding suggests that there is a cognitive component to "figuring out the strategy" of the video games. However, the correlation of ASVAB with gain score between different video sessions is fairly low, as table 7 shows. Appendix C presents the uncorrected correlations.

Table 6. Correlations among different indicators of infantry proficiency and different ASVAB composites

	MM	GT	EL	CL	AFQT
KD score	.38	.35	.32	.26	.32
Pop-up target–firing	.17	.13	.11	.08	.07
Pop-up target–zeroing	.00	.01	.02	.03	.02
Pop-up target–total	.16	.12	.11	.07	.08
Hands-on total	.69	.65	.66	.53	.62
TRAP1 (video)	.35	.32	.29	.22	.27
TRAP2 (video)	.31	.38	.36	.29	.34
SAFARI1 (video)	.41	.38	.36	.29	.34
SAFARI2 (video)	.46	.43	.42	.34	.39

NOTE: Scores are corrected for range restriction but not for attenuation due to unreliability.

Table 7. Correlations among video-gain scores and different ASVAB composites (range corrected)

	MM	GT	EL	CL	AFQT
TRAP2-TRAP1	–.05	–.05	–.03	–.04	–.05
SAFARI2-SAFARI1	.06	.06	.07	.05	.06
SAFARI2-TRAP1	.09	.09	.10	.10	.09

NOTE: The four video tasks were administered in the following order: TRAP1, TRAP2, SAFARI1, SAFARI2. Small negative values occur if the corrected correlation is very close to zero.

MOS Differences

Table 8 shows that there were few differences in pop-up target and KD scores by MOS. This table also shows that each MOS has a range of rifle-firing abilities.

Table 8. Mean KD and pop-up target scores by MOS

	Riflemen (0311) n = 812	Machine gunners (0331) n = 259	Mortarmen (0341) n = 232	Average
KD score	177.3	187.6	188.5	184.5
Standard deviation	(76.7)	(68.6)	(67.4)	(70.9)
Pop-up target score	53.6	49.9	46.3	49.9
Standard deviation	(17.1)	(15.5)	(16.1)	(16.2)

Table 8 also shows that riflemen are highest of the MOSs on the pop-up target score and lowest on the KD score. Riflemen's pop-up target scores are 0.45 standard deviation (s.d.) more than mortarmen's scores and 0.23 s.d. higher than machine gunners' scores. One-way ANOVA shows the overall differences between MOSs to be significant ($p < .001$, $F = 16.41$ df 2, 1618), but the Tukey studentized range test shows that the only statistically significant differences were between riflemen (MOS 0311) and the other two MOSs ($p < .05$). In contrast, riflemen score lowest of the MOSs on KD score, by 0.16 s.d. under mortarmen and 0.15 s.d. under machine gunners. One-way ANOVA showed the overall differences in KD score to be marginally significant for such a large sample size ($p < .0023$, $F = 6.10$, df 2, 1646), and, as with pop-up target scores, the only significant difference was between riflemen and the other two MOSs.

When considering the usefulness of the two criteria in this study (KD score and pop-up target score), discrepancies of this magnitude are a cause for concern. Riflemen are expected to score higher than other MOSs on the JPM pop-up target score, since they practice more frequently. But it is surprising that riflemen have lower KD scores than the other MOSs.

Several explanations are possible. The first is that riflemen are less senior, and thus have had less time to learn how to do well on the KD requalification test. The mean time in service (in months) was 23.4 months for riflemen, 34.0 for machine

gunners, and 27.9 for mortarmen. These differences are highly significant for a one-way ANOVA ($F = 43.26$, $p<.0001$ df 2, 1693). The corrected correlation of KD score and time in service (TIS) was .13 overall, but correlations varied by MOS (.11 for riflemen, .15 for machine gunners, and .28 for mortarmen, uncorrected). The corrected correlation of pop-up target scores with TIS was lower (.09).

It is also significant that the lower mean TIS for riflemen is accompanied by a significantly smaller standard deviation (table 9). This suggests that Marines who become riflemen change MOSs or leave the Corps, whereas the other two MOSs have a more significant proportion of experienced personnel. For MOS 0311, the most experienced examinee had been in the Marines for 67 months, whereas troops with more than 67 months of experience made up 8 percent of MOS 0331 and 6 percent of MOS 0341.

Table 9. Distribution of time in service (TIS) by MOS

MOS	Mean	Standard deviation	Minimum	Maximum
0311	23.4	12.4	5.0	67.0
0331	34.0	22.9	4.0	126.0
0341	27.9	22.3	5.0	118.0

A second explanation is that KD scores reflect willingness to do what it takes to get ahead, as well as actual combat skills. Since KD scores are a factor in an infantryman's career, it is not surprising that pay grade also correlated with KD—and riflemen were also of a lower pay grade than the other specialties, with 76.2 percent of riflemen in grade E3 or below, compared to 72.9 percent of machine gunners and 72.2 percent of mortarmen. Pay grade correlated 0.25 with KD score overall (see table 10).

A third explanation is that KD scores were not as up-to-date as the JPM pop-up target scores. For example, KD scores could be more than 12 months out-of-date at the time of JPM testing. Large lag times would suggest that KD scores should be ignored because skills deteriorate. Table 11 indicates that lag times were sometimes extensive. Note that lag times were occasionally negative if KD scores were collected after JPM pop-up target testing.

Table 10. Correlations of TIS, paygrade, KD scores, and pop-up target scores

	KD score	Pop-up target score	TIS	Paygrade
KD score	1.00	.20	.13	.25
Pop-up target score	.20	1.00	.09	.11
TIS	.13	.09	1.00	.57
Paygrade	.25	.11	.57	1.00

Table 11. Lag time (in months) for KD scores by MOS

MOS	Mean	Standard deviation	Minimum	Maximum
0311	4.4	5.4	–4.0	41.0
0331	4.8	5.6	–2.0	28.0
0341	5.1	5.4	–2.0	36.0

Correlations

Table 12 shows the correlations between the alternative criteria and potential surrogates for rifle-firing ability. It shows the video firing task and, to a lesser extent, the core job-knowledge test correlated with HMF rifle scores. But the correlation of video firing with the pop-up scores (as opposed to KD scores) is low (.17). The uncorrected correlations are in appendix D. The plots for these relationships (figures 2 and 3) show that the relationship of video score to KD to is considerably stronger than to pop-up target score. It also shows that the restricted range of KD scores, with few scores under 190, masks the true (stronger) relationship of video scores to KD scores.

Table 12. Correlations of alternative criteria and potential surrogates for rifle-firing ability (corrected)

	KD score	Pop-up target score	Field proficiency	Field conduct	Training GPA	Rating	Video	Core job-knowledge test	Live-fire recency	Live-fire frequency
KD score	1.00	.20	.23	.19	.25	.16	.41	.31	.06	.06
Pop-up target score	.20	1.00	.09	.06	.09	.05	.17	.12	-.06	-.04
Field proficiency	.23	.09	1.00	.86	.27	.48	.22	.35	.18	.18
Field conduct	.19	.06	.86	1.00	.17	.41	.19	.29	.15	.14
Training GPA	.25	.09	.27	.17	1.00	.17	.35	.48	.18	.17
Rating	.16	.05	.48	.41	.17	1.00	.15	.26	.09	.11
Video	.41	.17	.22	.19	.35	.15	1.00	.36	.10	.10
Core job-knowledge test	.31	.12	.35	.29	.48	.26	.36	1.00	.11	.11
Live-fire recency	.06	-.06	.18	.15	.18	.09	.10	.11	1.00	.79
Live-fire frequency	.06	-.04	.18	.14	.17	.11	.10	.11	.79	1.00

These correlations suggest that, of the potential measures, video has the strongest potential to be a surrogate for KD scores, and that pop-up target scores are distinct from KD scores. Self reports of recency and frequency of practice are quite weakly related to either KD or pop-up target scores. Stepwise regression using the potential surrogates to predict rifle scores shows how little variance is explained by addition of other measures beyond the video marksmanship. The first step adds video marksmanship to the equation, with an r-squared value of .11 ($F = 126.37$). The second step adds the core job-knowledge test, for a total r-squared value of .12 ($F = 71.94$). No other single measure would improve r-squared by as much as 1 percent.

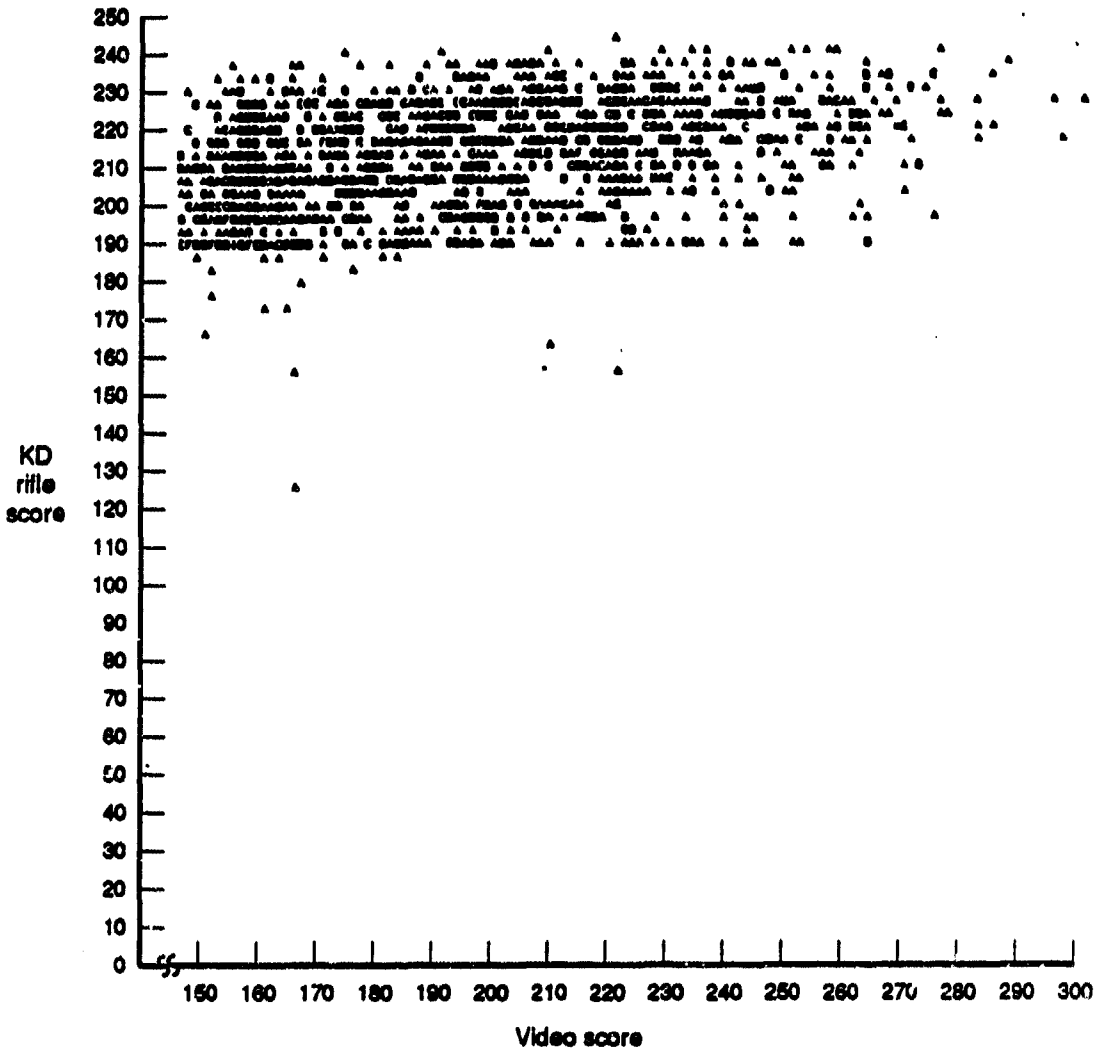

Figure 2. Relationship of KD rifle score to video score

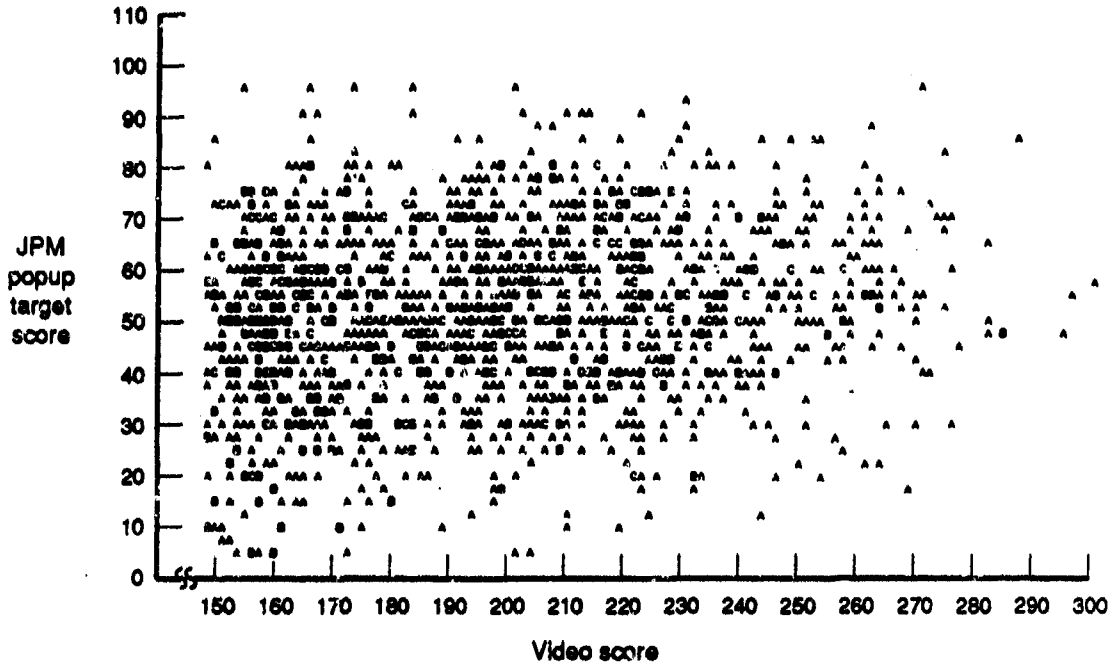

Figure 3. Relationship of JPM pop-up target score to video score

Practice Effects

Criteria

Another important topic to consider is the extent to which the recency of practicing a task contributes to its performance. Table 13 shows that most riflemen (0311s), not surprisingly, had zeroed or fired an M16A2 rifle more recently than had either machine gunners or mortarmen.

All things being equal, we would also expect infantrymen who have practiced more often in the past six months to do better on both the KD and the pop-up target tasks. Table 14 shows that riflemen also have slightly more frequent use of the M16A2; therefore, we would expect them to be better at shooting rifles than are machine gunners or mortarmen.

Table 13. Recency of task performance by MOS

MOS	Riflemen (0311) $n = 812$		Machine gunner (0331) $n = 259$		Mortarmen (0341) $n = 232$	
Zeroing a rifle						
Less than one week	21	(2.6)	7	(2.7)	9	(3.9)
Less than one month	148	(18.3)	30	(11.6)	35	(15.1)
Less than six months	326	(40.1)	94	(36.3)	82	(35.3)
Greater than six months	289	(35.6)	121	(46.7)	100	(43.1)
In training only	28	(3.4)	7	(2.7)	6	(2.6)
Firing a rifle						
Less than one week	43	(5.3)	2	(0.8)	0	(0.0)
Less than one month	142	(17.5)	11	(4.2)	2	(0.9)
Less than six months	256	(31.5)	46	(17.8)	21	(9.0)
Greater than six months	329	(40.5)	127	(49.0)	79	(34.1)
In training only	42	(5.2)	73	(28.2)	130	(56.0)

NOTE: Recency responses are answers to the question, "(What was the) last time you . . ." Percentages are in parentheses.

Table 14. Frequency of task performance by MOS

MOS	Riflemen (0311)		Machine gunner (0331)		Mortarmen (0341)	
Zeroing a rifle						
Have not performed in last six months	299	(36.8)	120	(46.3)	104	(44.8)
Once or twice	438	(53.9)	125	(48.3)	124	(53.4)
3 to 10 times	69	(8.5)	12	(4.6)	4	(1.8)
More than 10 times	6	(.8)	2	(.8)	0	
Total	812		259		232	
Firing a rifle						
Have not performed in last six months	362	(44.6)	204	(78.8)	210	(90.5)
Once or twice	344	(42.4)	47	(18.1)	21	(9.1)
3 to 10 times	93	(11.4)	6	(2.3)	1	(.4)
More than 10 times	13	(1.6)	2	(.8)	0	
Total	812		259		232	

NOTE: Frequency question was, "How many times have you done this task during the last six months?" Percentages are in parentheses.

Table 15 shows moderate relationships between recency of task performance and specific performance (i.e., zeroing or firing a rifle at a pop-up target) and demonstrates that 0311s have generally better performance with the M16A2 rifle. Table 16 shows that the relationship of recency to overall rifle-firing scores (.8 * firing a rifle at a pop-up target + .2 * zeroing a rifle) is stronger than for the recency of specific performance (i.e., just firing at a pop-up target or zeroing alone). Still, the correlation of recency to overall pop-up-target score is essentially zero (see table 12).

Table 15. Mean of specific performance by recency of task performance by MOS

MOS	Riflemen (0311) Mean	*n*	Machine gunner (0331) Mean	*n*	Mortarmen (0341) Mean	*n*
Zeroing a rifle						
Less than one week	57.1	(21)	32.1	(7)	69.4	(9)
Less than one month	58.1	(148)	35.8	(30)	33.6	(35)
Less then six months	53.2	(326)	37.8	(94)	39.6	(82)
Greater than six months	57.1	(289)	38.0	(121)	41.5	(100)
In training only	56.3	(28)	17.9	(7)	37.5	(6)
Firing a rifle						
Less than one week	55.6	(43)	71.0	(2)	--	(0)
Less than one month	54.3	(142)	55.3	(11)	53.0	(2)
Less than six months	53.0	(256)	48.5	(46)	41.8	(21)
Greater than six months	52.2	(329)	53.0	(127)	49.6	(79)
In training only	53.6	(42)	55.5	(73)	47.5	(130)

NOTE: Recency responses are answers to the question, "What was the last time you . . ." Numbers of examinees upon which means are based are in parentheses.

Table 16. Mean of overall pop-up target performance by recency of task performance by MOS

MOS	Riflemen (0311) Mean	*n*	Machine gunner (0331) Mean	*n*	Mortarmen (0341) Mean	*n*
Recency of zeroing a rifle						
Less than one week	52.7	(21)	51.6	(7)	44.8	(9)
Less than one month	56.7	(148)	49.4	(30)	47.1	(35)
Less than six months	51.8	(326)	50.5	(94)	43.2	(82)
Greater than six months	53.6	(289)	49.3	(121)	48.3	(100)
In training only	58.1	(28)	52.9	(7)	54.5	(6)
Recency of firing a rifle						
Less than one week	57.1	(43)	62.0	(2)	–	(0)
Less than one month	55.2	(142)	50.8	(11)	49.5	(2)
Less than six months	53.3	(256)	45.9	(46)	43.1	(21)
Greater than six months	52.7	(329)	49.9	(127)	48.5	(79)
In training only	53.2	(42)	51.9	(73)	45.5	(130)

NOTE: Numbers of examinees upon which means are based are in parentheses. Overall pop-up target performance was computed as (.8 * firing a rifle at a pop-up target 2 * zeroing a rifle).

Video Scores

The fourth question of this study is whether there are practice effects associated with the video tasks. As shown in table 17, examinees scored over a fifth of a standard deviation higher on the second administration of a video task within a test administration. This occurred for both the trapshooting and the safari video games, thus indicating that even a minor amount of practice within the same testing session could have a significant effect on scores. Test-retest reliability was .45 for pop-up targets, .68 for the trapshooting game, and .69 for the safari game. Since retest improvements for video were in the order of three-fourths standard deviation [7], practice effects could persist over a period of days. These improvements are large enough to affect the equating of tests, as they have for the numerical operations subtest of the ASVAB [9].

Table 17. Raw video scores by test administration (overall sample)

	n	Mean	Standard deviation
TRAP1	1,303	50.00	10.00
TRAP2	1,303	52.38	10.49
Difference	2.38/10 = 23.8% s.d.		
SAFARI1	1,303	50.00	10.00
SAFARI2	1,303	52.67	11.69
Difference	2.67/10 = 26.7% s.d.		

NOTE: TRAP1 and SAFARI1 were restandardized to mean 50, standard deviation 10 in order to facilitate comparisons.

Table 18 shows that those who have never played a video game and those who have played in the previous week differ by over 0.30 standard deviation in their mean performance. This is further evidence that practice has a positive influence on performance on computerized tests.

Table 18. Mean total standardized video score by recency of playing a video game

	Mean score	Standard deviation	Range
Less than one week ago	202.9	34.3	150–286
Less than one month ago	203.1	32.4	150–300
Less than six months ago	197.8	31.8	149–296
More than six months ago	199.8	32.0	150–295
Have never played a video game	192.5	32.0	149–275

CONCLUSIONS

- The correlation of known-distance (KD) and pop-up target scores was only .2. This result suggests that alternative measures of rifle-firing ability can be distinct.

- No present composite of the ASVAB predicts ability to fire at pop-up targets, so the validity of the ASVAB could be improved by adding tests that correlate with rifle-firing skills. ASVAB does somewhat better at predicting KD scores than at predicting pop-up target scores.

- The video firing games used in this research were reliable and moderately correlated with KD (.41); however, they were only weakly correlated with pop-up target scores (.17).

- Practice effects on the video firing games from 0.2 to 0.4 standard deviation were found. Consequently, even if computerized tests of rifle firing skills prove otherwise valid, practice effects would still be a concern. Practice effects can invalidate attempts to equate tests from different years.

- Noncomputer surrogates had correlations ranging from .16 to .31 for KD and from .05 to .12 for pop-up target scores. These figures indicate that noncomputer measures *do not* yield results similar to either performance test of rifle-firing skills.

As a whole, these results indicate that rifle-firing skills are quite context-dependent. Current Marine Corps efforts to develop tests of the ability to hit pop-up targets are important. Only greater attention to the specifics of rifle-firing skills and practice effects will yield alternative measures that should be used in conjunction with ASVAB.

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1. The numbers in parentheses are internal CNA control numbers.

APPENDIX A

SCORESHEETS FOR THE POP-UP TARGET TASKS

LF01AB: BATTLESIGHT ZERO M16A2 RIFLE

0300

SCORESHEET

Scorer: _____ Marine: _____

Date: _____ ID: _____

Last time you did: Battlesight Zero M16A2 Rifle (Known Distance)
< 1 wk ___ < 1 mo ___ < 6 mos ___ > 6 mos ___ Never ___

How many times have you done this task during the last six months?
None ___ 1 or 2 ___ 3 to 10 ___ > 10 ___

Say: This course of fire will test your ability to BZO your rifle. Now that you have received the range safety and procedure brief, I want you to put mechanical zero on your rifle.

NOTE TO SCORER: Allow 2 minutes for all seven shooters to put mechanical zero and score performance step GO/NO-GO. If a NO-GO is scored tell the Marine to correct the error.

PERFORMANCE STEPS	GO	NO-GO
1. Set weapon to mechanical zero correctly.	_____	_____

NOTE TO SCORER: Correct the Marine if he incorrectly moved sights.

After the first stage of fire the rifle may be zeroed.

2. Moved front sight the required number of "clicks."	_____	_____
3. Moved rear sight the required number of "clicks."	_____	_____
4. After rifle is zeroed Marine rotated elevation knob one click down on the rear sight.	_____	_____

LF01AB: BATTLESIGHT ZERO M16A2 RIFLE

PERFORMANCE STEPS	GO	NO-GO

NOTE TO SCORER: The Marine will repeat all 3 stages of fire and will be scored on the stage of fire that BZO is achieved.

LF02AB: ENGAGE TARGETS

0300

Equipment/Materials Required

Each Marine will wear the following uniform and equipment:
- Utility uniform
- Helmet
- Upperbody armor (flack jacket)
- Cartridge belt with first aid kit, 2 canteens, and 6 magazines

1 M16A2 rifle with sling
Ear plugs
41 5.56mm rounds (5 mazine with 6 rounds each and 1 magazine with 5 rounds)
Control panel (for targets)
PRC-77

Procedure to Set Up Station

1. RSO will brief each 7-man group (safety).
2. Raise range flag (daily).
3. Establish radio contact with range control and maintain contact IAW SOP.
4. Install batteries each morning at each target (remove each night and recharge).
5. Cause control panel operator to operation check the panel and targets.

Procedures To Be Performed Before Testing Each Marine

1. Check loading of magazines.
2. Check that rifle is set on semi auto fire.

Procedures to Administer and Score Test

1. As Marine travels the course cause the target(s) to pop-up.
2. Cause target(s) to go down after 5 seconds.
3. Maintain strict safety measures at all times.

LF02AB: ENGAGE TARGETS

TARGET NUMBER	HIT	MISS

Last time you did: Engage Targets
< 1 wk ___ < 1 mo ___ < 6 mos ___ > 6 mos ___ Never ___

How many times have you done this task during the last six months?
None ___ 1 or 2 ___ 3 to 10 ___ > 10 ___

LF02AB: ENGAGE TARGETS

0300 SCORESHEET

Scorer: _____ Marina: _____

Date: _____ ID: _____

Say: This test will cover your ability to engage targets in the offense. You will travel the course by following the trail. As a target appears you will shoot without command. You may use the standing and kneeling firing positions only. You will not use more than 3 rounds per target. If you hit the target with less than 3 rounds continue to move down the course. When you reach the end of the course you will expend all remaining rounds.

TARGET NUMBER		HIT	MISS
1.	Rounds fired _____	_____	_____
2.	Rounds fired _____	_____	_____
3.	Rounds fired _____	_____	_____
4.	Rounds fired _____	_____	_____
5.	Rounds fired _____	_____	_____
6.	Rounds fired _____	_____	_____
7.	Rounds fired _____	_____	_____
8.	Rounds fired _____	_____	_____
9.	Rounds fired _____	_____	_____
10.	Rounds fired _____	_____	_____
11.	Rounds fired _____	_____	_____
12.	Rounds fired _____	_____	_____
13.	Rounds fired _____	_____	_____
TOTALS	_____	_____	_____

APPENDIX B

CORRELATIONS AMONG DIFFERENT INDICATORS OF INFANTRY PROFICIENCY AND DIFFERENT ASVAB COMPOSITES, UNCORRECTED FOR RANGE RESTRICTION

APPENDIX B

CORRELATIONS AMONG DIFFERENT INDICATORS OF INFANTRY PROFICIENCY AND DIFFERENT ASVAB COMPOSITES, UNCORRECTED FOR RANGE RESTRICTION

	ASVAB composites				
Indicators	MM	GT	EL	CL	AFQT
KD score	.28	.26	.22	.17	.22
Pop-up target—firing	.16	.13	.10	.06	.07
Pop-up target—zeroing	.00	.01	.01	.03	.02
Pop-up target—total	.15	.12	.09	.06	.07
Hands-on total	.56	.51	.52	.37	.48
TRAP1 (video)	.26	.24	.20	.14	.19
TRAP2 (video)	.27	.25	.22	.15	.21
SAFARI1 (video)	.31	.29	.26	.20	.24
SAFARI2 (video)	.33	.30	.28	.21	.26

APPENDIX C

UNCORRECTED CORRELATIONS AMONG VIDEO-GAIN SCORES AND DIFFERENT ASVAB COMPOSITES

APPENDIX C

UNCORRECTED CORRELATIONS AMONG VIDEO-GAIN SCORES AND DIFFERENT ASVAB COMPOSITES

	ASVAB composites				
Gain scores	MM	GT	EL	CL	AFQT
TRAP2–TRAP1	.00	.00	.02	.02	.01
SAFARI2–SAFARI1	.03	.02	.03	.01	.02
SAFARI2–TRAP1	.05	.04	.05	.05	.05

NOTE: The four video tasks were administered in the following order: TRAP1, TRAP2, SAFARI1, SAFARI2.

APPENDIX D

UNCORRECTED CORRELATIONS OF TIME IN SERVICE, PAYGRADE, KD SCORES, AND POP-UP TARGET SCORES

APPENDIX D

UNCORRECTED CORRELATIONS OF TIME IN SERVICE, PAYGRADE, KD SCORES, AND POP-UP TARGET SCORES

	KD score	Pop-up target score	TIS	Paygrade
KD score	1.00	.19	.16	.20
Pop-up target score	.19	1.00	.09	.10
TIS	.16	.09	1.00	.62
Paygrade	.20	.10	.62	1.00

APPENDIX E

UNCORRECTED CORRELATIONS OF ALTERNATIVE CRITERIA AND POTENTIAL SURROGATES FOR RIFLE-FIRING ABILITY

APPENDIX E

UNCORRECTED CORRELATIONS OF ALTERNATIVE CRITERIA AND POTENTIAL SURROGATES FOR RIFLE-FIRING ABILITY

	KD score	Pop-up target score	Field proficiency	Field conduct	Training GPA	Rating	Video	Core job-knowledge test	Live-fire requency	Live-fire frequency
KD score	1.00	.19	.17	.14	.14	.12	.35	.19	.04	.04
Pop-up target score	.19	1.00	.08	.05	.06	.05	.15	.11	–.07	–.05
Field proficiency	.17	.08	1.00	.85	.16	.46	.16	.27	.16	.17
Field conduct	.14	.05	.85	1.00	.09	.40	.14	.22	.14	.13
Training GPA	.14	.06	.16	.09	1.00	.12	.25	.28	.15	.16
Rating	.12	.05	.46	.40	.12	1.00	.11	.21	.08	.10
Video	.35	.15	.16	.14	.25	.11	1.00	.25	.07	.08
Core job-knowledge test	.19	.11	.27	.22	.28	.21	.25	1.00	.08	.10
Live-fire recency	.04	–.07	.16	.14	.15	.08	.07	.08	1.00	.79
Live-fire frequency	.04	.05	.17	.13	.16	.10	.08	.10	.79	1.00